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ABSTRACT

A physiological measure, which does not possess the limitations of traditional self-report measures of test anxiety, was used to measure arousal during a simulated achievement testing situation. A sample of 119 fifth and sixth grade students ranked four academic subjects (arithmetic, language arts, social studies, and science) from "most difficult" to "least difficult". All Ss were then administered abbreviated achievement subtests over the four academic content areas and concurrent physiological (galvanic skin response) measures were obtained. The results of this study are consistent with those found in other similar investigations. Artihmetic appears to produce higher levels of anxiety and arousal than any other single content area. Further investigations of relationships between arousal and concurrently obtained achievement scores and a closer examination science and social studies areas are suggested. (Author)

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AN INVESTIGATION OF RELATIONSHIPS BETWEEN PERCEIVED SUBJECT MATTER DIFFICULTY AND PHYSIOLOGICAL AROUSAL DURING ACHIEVEMENT TESTING

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The antecedents, nature and consequences of test anxiety among elementary children have been topics that have stimulated the interest of numerous researchers in recent years. In general the results of many investigations have concluded that test anxiety is a phenomenon of great importance in the educational setting because testing and the use of test results in decision making is so common.

Despite the great interest, the apparent implications and the desire of educators to acquire an extensive body of knowledge about all aspects of test anxiety, a comprehensive and widely held theory has failed to emerge (Chandler, 1969). The numerous inconsistencies in the research literature and many questions yet unanswered have been inhibiting factors in the development of an adequate theory.

Some investigators have attributed the inconsistencies in test anxiety results to the measurement instruments which have been used (Krause, 1961; Lazarus, 1966). The most common method of measuring test anxiety is the self-report scale to which the individual reports his own unique, phenomenological experience of anxiety. There are several problems with self-report instruments. The validity of such scales, is dependent upon the individual's accurate introspective report of his affective experiences. Such dependency may present some unique problems to the anxiety researcher, because these indicators may not

have entirely consistent referents concerning the phenomenological experience of affect.

The most significant problem of self report test anxiety scales, particularly as it applies to the present study, is the availability of only one score to represent test anxiety in all testing situations. Because of this deficiency researchers have had to satisfy themselves with the treatment of test anxiety as a general phenomenon which exists to the same degree for each individual with respect to all tests. The availability of only a single score has necessitated this approach to the study test anxiety. If indeed test anxiety is a stable function across all testing situations then traditional self-report techniques are appropriate, however, there is some reason to believe that anxiety is not a stable phenomenon.

Lazarus (1966) has contended that different stimulus situations will create different levels of arousal depending upon the threat of those stimulus conditions as perceived by the observer. Applying this argument to an achievement testing situation one could reasonably expect a variation in experienced anxiety when several content area achievement tests, each posing different degrees of threat to the test taker, are administered. A logical assumption, based upon Lazarus' (1966) reasoning, would be that the more difficult and hence more threatening the content area subtest, the more highly anxious the individual would become. Conversely, tests over subject matter perceived as less difficult and less threatening should result in lower levels of anxiety. The purpose of the present study was to investigate whether relationships existed between academic content area difficulty and measures

of test anxiety specific to different content area subtests.

Although some efforts have been made to measure situation specific test anxiety with self-report instruments (Forhetz, 1970) these scales were not designed for that purpose. Therefore, another measurement tool was sought which would overcome the reliance upon the self-report single score measure, by yielding accurate estimates of differential levels of test anxiety in an achievement testing situation. Behavioral indices, as discussed by Tolman (1968) were given consideration but rejected because they have failed to produce convincing demonstration of their effectiveness in estimating anxiety processes. Ratings made through behavioral observation have not proved to be a dependable basis of influence about anxiety (Lazarus, 1966).

A second alternative to self-report scales, and one which has become increasingly popular in recent years, is the physiological measurement of affective experiences. Improved instrumentation and new processes to reduce and analyze psychophysiological recordings rapidly and effectively are factors which have spurred the interest of social scientest in physiological research. A physiological measure which has gained favor among some anxiety researchers is the galvanic skin response (GSR). The GSR is an index of the changes in the level of activation of the individual which are obtained by measuring the degree of resistance afforded by certain parts of the body to the passage of a minute electrical current through their surface (Duffy, 1962). The GSR has been found to be very sensitive of emotional arousal and is convenient as an indicator of autonomic activity, factors which had led to its widespread application in psychological investigation (Levi, 1967: Edelberg & Burch, 1962).

The focus of the present study was on the measurement of test anxiety in an achievement test setting where different academic content area subtests were administered. The GSR physiological index was selected for use in this investigation because it allowed for the collection of continuous data thus providing the opportunity of determining whether subtests over subject matter rated as "most difficult" and those perceived as "least difficult" result in differential arousal responses.

The following research hypotheses were investigated in the present study:

(1) Greater physiological arousal will be associated with that content area rated as "most difficult" by the majority of Ss than for the academic content area perceived as "least difficult" by the majority of Ss.

(2) Those Ss rating arithmetic as "most difficult" will manifest higher physiological arousal during the administration of an arithmetic subtest than those Ss rating arithmetic as "least difficult".

(3) Those Ss rating language arts "most difficult" will manifest higher physiological arousal during the administration of a language arts subtests than those Ss rating language arts as "least difficult".

(4) Those Ss rating social studies as "most difficult" will manifest higher physiological arousal during the administration of a social studies subtest than those Ss rating social studies as "least difficult".

(5) Those Ss rating science as "most difficult" will manifest higher physiological arousal during the administration of a science subtest than those Ss rating science as "least difficult".

Method

Sample

The experimental sample consisted of 61 male and 58 female fifth and sixth grade students from three school districts in Illinois. One school each from

from northern, central, and southern Illinois were used in the investigation, thus giving the sample a representative geographical, racial and socioeconomic balance within the state. Twelve subjects from each of 12 classrooms were selected for participation in the study on the basis of several criteria; (a) it was necessary to have recent IQ and achievement test scores available and (b) equal numbers of Ss from each of the three IQ ranges, 89 and below, 90-110, and 111 and above. Random selection of Ss was made from those who met these criteria.

Instrumentation

A short achievement test consisting of four ten-minute subtests was constructed from items contained within the SRA Achievement Battery. The arithmetic, language arts, social studies and science content areas were tested. The abbreviated achievement battery was developed specifically for use in the present study, and for the sole purpose of creating arousal levels that might be expected during a normal achievement testing situation. The instrument was neither intended nor used for the purpose of measuring achievement.

Apparatus

An E & M Instrument Co. "Physiograph Six" polygraph recorder was the apparatus used to collect GSR data. Through various modifications of the original equipment it was possible to obtain GSR measures on twelve subjects from each participating classroom. A silver/silver chloride (Ag/AgCl) active electrode and a large silver plated reference electrode were attached to one hand and wrist of each subject according to the procedure used by Nighswander (1970). Wires thirty feet in length made it possible to extend the electrodes from the Physiograph to every position in the classroom.

A sodium chloride (Sanborn-Redux) electrode paste was used as a conductive medium between the metallic electrode surfaces and the skin.

Experimental procedure.

Several weeks prior to the experiment a graduate student, who otherwise had no contact with the experimental Ss, distributed a brief questionnaire to all members of the participating classes. Ss were asked to rank the four academic content areas, arithmetic, language arts, social studies and science, from most to least difficult.

The day before the experiment was conducted, the experimenters (E_1 & E_2) introduced themselves to the Ss and briefly described the procedures and activities of the next day and informed them that an achievement test would be administered. On data collection day, prior to the commencement of classes, and before the students entered their rooms, the Physiograph was moved in and positioned at the rear of the classroom behind a large folding screen. Electrodes were extended to the desks of the Ss and the wires were taped to the floor. When the students entered the room the 12 experimental Ss were instructed to proceed to the restrooms and wash their hands carefully. Upon return, each S's non-dominant hand and wrist was given an additional cleaning with alcohol whereupon the electrodes were attached. The experiment began immediately after all electrodes were attached.

The first 15 minutes of the experiment was an adaptation period to allow the Ss to adjust to the feel and novelty of the electrodes. During this time E_2 showed a nonarousing film slide while E_1 calibrated the GSR instrumentation. When adaptation was achieved the four ten-minute subtests were administered

consecutively in an order which had been randomly determined prior to the collection of data. Continuous GSR data were obtained during each of the subtest administrations and for a 15 minute period of time following completion of the last subtest. During this posttest phase of the study another set of film slides were shown. The entire experiment was conducted in approximately 1 3/4 hours.

Analysis of data

The GSR recordings obtained during the experiment consisted of sustained changes in basal skin resistance from a pre-established baseline. Resistance values were converted to conductance units as recommended by Lacy & Siegel (1948) and changes in mean conductance from the preceeding pretest baseline or the preceding tests, were computed. For every experimental S a change score, in conductance units, (change from the immediately preceding conductance level) was available for each of the four SRA content area subtests. The analyses consisted of computing t-tests for differences between conductance means for groups rating content areas as "most difficult" and "least difficult". A .05 level of significance was used in testing all hypotheses.

Results

The results of the study are found in Table 1. Three of the five research hypotheses were confirmed. Hypothesis number one, was concerned with differences in conductance levels between the academic area rated "most difficult" by the greatest number of Ss and the academic area rated "least

difficult" by the greatest number. Arithmetic was considered most difficult and language arts least difficult. A t-test for differences between the mean conductance levels showed that the arithmetic mean was significantly greater ($p < .05$) than the language arts mean conductance level.

TABLE 1

Conductance Means, Standard Deviations and Tests of Significance for Groups Rating Academic Subject Matter Areas as "Most Difficult" and "Least Difficult"

CONTENT AREA SUBTESTS	GROUPS: Most Difficult			Least Difficult			
	n	$\bar{X}$	SD	n	$\bar{X}$	SD	t
Arithmetic - Lang. Arts	37	1.62	2.11	37	.72	1.42	2.12*
Arithmetic	37	1.62	2.11	35	.79	1.99	1.69*
Language Arts	14	1.45	1.07	37	.72	1.42	1.71*
Social Studies	17	.82	.88	10	.62	1.2	.50
Science	17	1.07	.88	11	.84	1.0	.51

*$p < .05$

Hypotheses 2, 3, 4 and 5 were formulated for purposes of testing whether those Ss who rank a particular content area as "most difficult", experience greater arousal during a test over that subject matter than Ss who rank the same academic content area as "least difficult". The second and third research hypotheses were supported. For both arithmetic and language arts, those Ss ranking these two academic areas as most difficult had higher group mean conductance levels than their counterparts who had ranked the corresponding areas as least difficult ($p < .05$).

The last two hypotheses were not confirmed. No significant differences between conductance means for groups indicating social studies or science most and least difficult were found.

Discussion

The results of this investigation appear to add very meaningfully to the wealth of knowledge that has been developed on the topic of test anxiety. Certainly the study has provided evidence which indicates that test anxiety is not a stable function across all types of achievement tests and therefore may not be appropriately represented by a single score alone. Lazarus' (1966) contention that situations varying in threat value will create differential levels of physiological arousal has been supported in part. For two of the four SRA subtests administered (arithmetic and language arts), Ss who reported these academic areas as most difficult - and we might assume more threatening - experienced greater physiological arousal during corresponding subtests than Ss who reported those areas less difficult.

These results relate meaningfully to those reported in other studies of a somewhat similar nature. Nighswander and Beggs (1971) also found that the mean conductance level for all Ss combined, (perceived difficulty was not of concern), was greatest during the arithmetic subtest than any of the other three SRA subtests. In the present study the group of Ss who reported arithmetic as most difficult had a higher conductance mean than groups indicating other content areas as most difficult. Neale, Gill and Tismer (1970) in an interesting study of relationships between attitudes toward

academic subjects and achievement also found that attitudes toward arithmetic were lowest of the four areas sampled and that a significant relationship existed between arithmetic attitude scores and arithmetic achievement for boys. Forhetz (1970) conducted unique study of test anxiety in which he administered a self-report scale (the Test Anxiety Scale for Children) on repeated occasions to Ss reporting arithmetic as "most difficult" and spelling as "least difficult". His results showed that the scores on the TASC, which was administered concurrently with the SRA Arithmetic subtest, were significantly higher than TASC scores obtained in close temporal proximity to the spelling subtest.

A common thread running through the results of all these studies focuses on the arithmetic content area. Attitudes toward arithmetic are low, and arithmetic had been rated as most difficult of all subject matter areas sampled. These attitude and perceived difficulty measures were found to be related to achievement scores and to both self-report and physiological measures of anxiety and arousal relative to arithmetic subtests.

The results corresponding to the language arts subtest (with respect to the first hypothesis) were consistent with Forhetz's (1970) findings. His Ss reported spelling (a part of the language arts subtest) as least difficult and their TASC scores obtained concurrently with the administration of the spelling test, were lower than those associated with the arithmetic subtest.

For the four hypotheses related to comparisons between conductance means of Ss rating the four academic subjects as most and least difficult, the arithmetic and language arts results were as hypothesized. Ss rating these two areas "most difficult" had significantly higher mean conductance

scores than those rating them as "least difficult". The social studies and science areas did not produce results supporting the third and fourth hypotheses. Although the conductance means associated with the "most difficult" perceptions were higher, the differences were not significant at the .05 level. The mean conductance levels for the "least difficult" groups approximated those associated with the arithmetic and language arts subtest, however, the conductance means for the "most difficult" social studies and science groups were much lower than for the other two content areas. These results indicate that perceptions of content area difficulty for social studies and science may not differentially affect physiological responding during the administration of corresponding subtests.

Several areas for further investigation are suggested in reviewing the results of this study. A follow-up of the present investigation will focus on relationships between physiological measures of arousal and concurrently obtained achievement subtest scores. In the present investigation, the subtests were used for the sole purpose of creating arousal. Future studies, which would permit the collection of both physiological and achievement measures simultaneously, would hopefully allow for the identification of the stimuli within an achievement testing situation that could create threat and trigger high levels of physiological responding.

The science and social studies results also seem to point to the need for further investigation. Although no significant relationships were discovered here, a replication with larger samples would be recommended before drawing any definite conclusions.

Summary

A physiological measure, which does not possess the limitations of traditional self-report measures of test anxiety, was used to measure arousal during a simulated achievement testing situation. A sample of 119 fifth and sixth grade students ranked four academic subjects (arithmetic, language arts, social studies, and science) from "most difficult" to "least difficult". All Ss were then administered abbreviated achievement subtests over the four academic content areas and concurrent physiological (galvanic skin response) measures were obtained. The results showed:

(1) Physiological arousal during a subtest over the content area rated "most difficult" (arithmetic) by most Ss was significantly higher ($p < .05$) than arousal during a subtest over the content area (language arts) rated "least difficult" by most Ss;

(2) Ss rating arithmetic or language arts content areas as "most difficult" experienced significantly higher arousal during subtests over these areas than Ss who rated corresponding content areas as "least difficult".

(3) No significant differences in physiological arousal were obtained during subtests over science and social studies for Ss rating these two content areas as "most difficult" and "least difficult".

The results of this study are consistent with those found in other similar investigations. Arithmetic appears to produce higher levels of anxiety and arousal than any other single content area. Further investigations of relationships between arousal and concurrently obtained achievement scores and a closer examination science and social studies areas are suggested.

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